DOCKET: 52-001

DATE: 2/18/93

NOTE TO: Document Control Desk

FROM: Chester Poslusny, PM, NRR

SUBJECT: DOCKETING OF ABWR INFORMATION RELATED TO DESIGN CERTIFICATION REVIEW

Document Date: 2/16/93

Subject: submittal supporting accelerated ABWR review schedule

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February 16, 1993 Docket No. STN 52-001

Chet Poslusny, Senior Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of the Nuclear Reactor Regulation

Subject: **Submittal Supporting Accelerated ABWR Review Schedule - Proposed Severe Accident Input**

Dear Chet:

Enclosed is draft GE proposes as severe accident input into Tier 2. This list was developed by consideration of the key issues deemed as important to the ABWR ability to mitigate a severe accident. Reference was made to SECY-90-016 and its progeny to ensure that the full complement of issues was examined.

Only a few of these items are suitable for inclusion in ITAAC. Based on discussions with both GE and NRC management, it is concluded that the crosstie for the firewater system, the containment overpressure protection system and the lower drywell flooder should be identified in ITAAC. However, given the state of the art in accident management, it is not appropriate to specify these systems in detail in ITAAC. The details should only be in Tier 2.

Please provide a copy of this transmittal to John Manninger and Bob Palla.

Sincerely,

Jack Fox

Jack Fox
Advanced Reactor Programs

cc: Carol Buchholz (GE)
Jack Duncan (GE)
Norman Fletcher (DOE)

See attached distribution
per C Poslusny

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ABWR Features to Mitigate Severe Accidents

The ABWR has been designed to prevent the occurrence of a core damage accident. In fact, the probability of a core damage accident is less than 1 chance in 1 million. This represents an improvement in severe accident prevention when compared to current plants. In the extremely unlikely event of a core damage accident, the ABWR containment has been designed with specific mitigating capabilities. These capabilities not only mitigate the consequences of a severe accident but also address uncertainties in severe accident phenomena. The capabilities are listed below along with a discussion of the specific severe accident phenomena that the mitigation devise is addressing. The severe accident issues addressed are consistent with the issues discussed in SECY 90-016.

Firewater Addition System

This system not only can play an important role in preventing core damage, it is the primary source of water for flooding the lower drywell should the core become damaged and relocate into the containment. The drywell spray mode of this system not only provides for debris cooling, but it is capable of directly cooling the upper drywell atmosphere and scrubbing airborne fission products. This system has sufficient capacity to cover the core debris ex-vessel and provide debris cooling and scrub fission products released as a result of continued core-concrete interactions.

The firewater addition system operating in the drywell spray mode will also reduce the consequences of a suppression pool bypass or containment isolation failure. This is due to the fission product removal function performed by this mode of operation. Fission products will be scrubbed by the sprays prior to leaving the containment.

The firewater addition system has been sized to optimize the containment pressure response. The system is capable of delivering water to the containment up to the setpoint pressure of the COPS system. The flow rate, nominally 0.055 m^3/sec at runout and 0.044m^3/sec at the COPS setpoint, is sufficient to allow cooling of the core debris, while maximizing the time until the water level reaches the bottom of the vessel, at which point it is turned off.

Lower Drywell Flooder

The lower drywell flooder system has been included in the ABWR design to provide alternate cavity flooding in the event of core debris discharge from the reactor vessel and failure of the firewater addition system. This system is actuated from the melting of a fusible plug. The temperature set point for the plug is 533 K. The system consists of ten 4 inch diameter lines located about 4 m below the normal suppression pool water level discharging into the lower drywell about 1 m above the floor. Assuming only 9 of the 10 flooders open, the total flooder flow would be 97 kg/s. By flooding after the introduction of core material, the potential for energetic core-water interactions during debris discharge is minimized. The flooder will cover the core debris with water providing for debris cooling and scrubbing any fission products released from the debris due to core-concrete interactions.

Containment Overpressure Protection

The COPS is part of the atmospheric control system and consists of two 8-inch diameter overpressure relief rupture disks mounted in series on a 14-inch line which connects the wetwell airspace to the stack. This system will provide for a scrubbed release path in the event that pressure in the containment cannot be maintained below the structural limit. This controlled release will occur at a containment pressure of 0.72 MPa (90 psig). This system is beneficial for several of the severe accident issues. In cases with continued core-concrete attack, or those with no containment heat removal operational, the containment will pressurize. The COPS provides a controlled release path which will mitigate the fission product releases. This is an example of how uncertainties in severe accident behavior, i.e. debris coolability, are addressed by the ABWR design.

Vessel Depressurization

The ABWR reactor vessel is designed with a highly reliable depressurization system. This system plays a major role in preventing core damage, however, even in the event of a severe accident, the RPV depressurization system can minimize the affects of high pressure melt ejection. If the reactor vessel would fail at an elevated pressure, fragmented core debris could be transported into the upper drywell. The resulting heatup of the upper drywell could pressurize and fail the drywell. Parametric analyses performed in Section 19AE of the ABWR SSAR indicate that even in the event of direct containment heating, the probability of early drywell failure is quite low. The RPV depressurization system further decreases the probability of this failure mechanism.

Lower Drywell Design

The details of the lower drywell design are important in the response of the ABWR containment to a severe accident. Six key features are described below.

Sacrificial Concrete

The floor and walls of the ABWR lower drywell include a 1.5 meter layer of concrete above the containment liner. This is to insure that debris will not come in direct contact with the containment boundary upon discharge from the reactor vessel. This added layer of concrete will protect the containment from possible early failure.

Basaltic Concrete

The sacrificial concrete in the lower drywell of the ABWR has been constructed of low gas content concrete. The selection of concrete type is yet another example of how the ABWR design has striven not only to provide severe accident mitigation, but to also address potential uncertainties in severe accident phenomenon. Here, the uncertainty is whether or not the core can be cooled by flooding the lower drywell. For scenarios in which the lower drywell flooder is unable to cool the core debris, the concrete type selected will result in a very low gas generation rate. This translates into a long time to pressurize the containment. This is important because time is one of the key factors in aerosol removal.

Sump Protection

The lower drywell sumps are protected such that a substantial amount of core debris will not enter. This maximizes the upper surface area between the debris and the water and maximizes the potential to quench the core debris.

Increased Floor Area

The floor area of the lower drywell has been maximized to improve the potential for debris cooling. The lower drywell floor area of 88 m^2 exceeds the ALWR Utility Requirements Document criteria of 0.02 M^2/MWth.

Wetwell-Drywell Connecting Vents

The flow area between the lower and upper drywell has been designed in a way to allow adequate venting of gases generated in the lower drywell. The connecting vents flow area is 11.25 m^2. This is important when considering the steam generation rates associated with fuel-coolant-interactions in the lower drywell.

The path from the lower to the upper drywell includes several 90 degree turns. This tortuous path enables core debris to be stripped prior to transport into the upper drywell minimizing the consequences from high pressure melt ejection. Also important when considering high pressure core melt scenarios, the configuration of the connecting vents will result in the transport of some core debris directly into the suppression pool. This is preferable to transport into the upper drywell and would result in the debris being quenched with only a slight increase in the suppression pool temperature.

Solid Vessel Skirt

The vessel skirt in the ABWR does not have any penetrations which would allow the flow of water from the upper drywell directly to the lower drywell. This ensures a very low probability that water is in the lower drywell before the time of vessel failure. Thus, large scale fuel-coolant interactions are precluded.

Inerted Containment

One of the important severe accident consequences is the generation of combustible gasses. Combustion of these gasses could increase the containment temperature and pressure. The ABWR containment will be operated inerted to minimize the impact from the generation of these gasses.

Containment Isolation

The ABWR containment design has striven to minimize the number of penetrations. This impacts the severe accident response due to a smaller probability of containment isolation failure. All lines which originate in the reactor vessel or the containment have dual barrier protection which is generally obtained by redundant isolation valves. Lines which are considered non-essential in mitigating an accident isolate automatically in response to diverse isolation signals. Lines which may be

useful in mitigating an accident have means to detect leakage or breaks and may be isolated should this occur.

Upgraded Low Pressure Piping

The low pressure piping in the ABWR has been upgraded to withstand higher pressure. This reduces the probability of an interfacing system LOCA and the severe accident consequences associated with such an event.

Drywell-Wetwell Vacuum Breakers

The ABWR contains eight 20-inch diameter vacuum breakers which provide positive position indication in the control room. They have also been located high in the wetwell to reduce potential loads occurring during pool swell. The result of the vacuum breaker design in the ABWR is to reduce the potential for suppression pool bypass.

Overall Containment Performance

The design of the ABWR containment provides for holdup and delay for fission product release should the containment integrity be challenged. Long term containment pressurization is governed by the generation of decay heat and non-condensable gases. The primary source of non-condensable gas generation is metal-water reaction of the zirconium in the core. This is accommodated by a relatively large containment volume. The mitigating systems discussed above ensure that the decay energy results in steam production. The suppression pool and substantial containment heat sinks absorb this energy, resulting in very slow containment response which ensure ample time for fission product removal.

Key Severe Accident Modelling Parameters

Table 1 provides a list of key severe accident modelling parameters. This list has been derived from the discussions presented above and from a variety of ABWR severe accident evaluations.

Table 1

Key Severe Accident Parameters

Parameter Description	Value	Relates to What Feature?
Core Power	3926 MW	Containment Performance
El. of Top of Fuel	9.05 m	Containment Performance
Normal Water Level	13.26 m	Containment Performance
ADS Area	.07m^2	Vessel Depressurization
Total Zr in Core	72,550 kg	Containment Performance
Concrete Type	Basaltic	Basaltic Concrete
Compartment Volume		
Lower Drywell	1860 m^3	Containment Performance
Upper Drywell	5490 m^3	Containment Performance
Wetwell	9585 m^3	Containment Performance
Floor Area		
Lower Drywell	88 m^2	Lower Drywell Flooder
Upper Drywell	610 m^2	Containment Performance
Wetwell	507 m^2	Lower Drywell Flooder
Overflow Elevation		
LDW to Wetwell	-4.55 m	Lower Drywell Flooder
UDW to Wetwell	7.35 m	Firewater Addition System
Heat Sink Surface Area		
Lower Drywell	589 m^2	Containment Performance
Upper Drywell	1720 m^2	Containment Performance
Wetwell	2348 m^2	Containment Performance
LDW to UDW vent area	11.3 m^2	Connecting Vents
Lower Drywell Flooder		
Elevation	-10.5 m	Lower Drywell Flooder
Area	.073 m^2	Lower Drywell Flooder
Plug Temperature	533 K	Lower Drywell Flooder
Suppression Pool Mass	3.6×10^6 kg	Containment Performance